Mars Surveyor in Mangala Valles: 1. Site Justification and Mission Scenario; Mary G. Chapman[1]; US Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001.

As a scientifically promising potential Surveyor Landing Site, Mangala Valles was recently approved for geologic analysis and initial mission planning (identifying operational scenarios and exploration strategies). Outlined in this abstract is a site justification and preliminary mission scenario.

Site Justification

(1) The search for life. Mangala Valles is a highly relevant area for exobiologic studies. The site offers access to recent and ancient rocks that can be sectioned and examined for evidence of fossils. Thermal systems are thought to have played a key role in the origin and evolution of life on Earth; areas with such proposed systems are thus important targets in searching for a martian fossil record [1]. The Mangala channel may provide such a setting because it emanates from a likely volcano/tectonic graben of Memnonia Fossae and therefore may have been sourced by thermal waters [2,3]. Young channel outflows and lake beds are exobiologic targets, because recent water outflows may have exposed and deposited molecular evidence of extant life and ice-covered lakes might have been sites for life's "last stand" on the martian surface [4]. Some channel deposits of Mangala Valles are as young as Amazonian in age [2,5-8] and the Mangala Valles channel contains several large craters where Hesperian and Amazonian episodic flooding ponded water and deposited lacustrine deposits [9]. In addition, Mangala Valles debouches onto Amazonis Planitia, a region that has been suggested to have been covered by a global circumpolar ocean [10-14].

(2) Resource assessment. The catastrophic flooding channel of Mangala Valles is a complex area containing terrains of variable type, composition, and age. Hesperian to Amazonian volcanic and sedimentary rocks are interbedded within a channel complex cut into Noachian highland materials. The different geologic terrains within Mangala Valles may provide access to unique rock types of scientific promise for resource assessment (gravels, cinders, lime?), but all locales contain easy access to sedimentary rocks.

(3) Geologic history. The understanding of localized volcanic/tectonic interactions, volcanic deposits, and nature of the highland-lowland dichotomy are primary geologic science goals for future missions [15]. Floods of Mangala Valles appear to emanate from a Memonia Fossae graben [16] as do possible lava flows [2]. Detailed visual examination, rock and soil sampling, and chemical/mineral analyses at the head of the Mangala channel may shed light on the nature of the Memnonia Fossa and its emanations. In addition, the highland-lowland boundary scarp terminates the Mangala channel and may be accessed by visual examination.

(4) Volatile and climatic history. Formation of outflow channels has been attributed to catastrophic flooding [17], glacial erosion [18], a combination of flooding and glacial processes [19], and debris flows [10]. Investigation of Mangala Valles by a networked set of vehicles (that include detailed camera visualization and sample-return capabilities) will cover the extended study area and try to determine the nature of channel formation. Clues to the ancient climate can be provided by sampling Noachian- and Hesperian-age rocks at the site, as rock compositions and physical characteristics establish a set of climatic conditions necessary for different rocks to form.

Preliminary mission scenario

The length of Mangala Valles channel system (about 850 km long) and the presence of numerous sites of high scientific interest along it argue for a networked mission configuration with considerable mobility built in. A nominal configuration would consist of a lander with a rover for studies near the landing site and balloon and multiple balloon-borne surface probes for more distant studies. To maximize power to the solar array and to provide a large landing ellipse in a hazard-free area, the landing site should be located in the southernmost areas of the channel that are wide and relatively smooth. A short- or medium-range rover will be used to carry out investigations within sight of the lander and sample return will only occur at the landing site. Because of the length of the channel system and the likelihood of encountering impassable rough terrain, a complete traverse of the system will necessitate a balloon [20]. The Mangala Valles mission scenario includes only one landing/rover site, but multiple locales/features of interest that can be explored by balloon and multiple surface probes. One scenario of this proposal is that the camera systems would not be mounted on the lander or rover, but carried on a balloon. The balloon would be initially tethered to the lander, so rover experiments could be monitored visually. At the conclusion of the rover phase, the balloon would be released and would take images of the landing site and surroundings during its ascent. This set of nested images should allow unambiguous identification of surface features and avoid the difficulty and potential errors in identifying the landing site that occurred with the Viking missions.

Detailed imaging of the channel system would be carried out as the balloon drifts. In addition, it may be possible to conduct some experiments from the balloon when it descends at night. As part of the balloon traverse, several probes could be jettisoned from the balloon to conduct surface experiments; their landing locations would be monitored by the balloon camera. Although this is not an engineering study, a detailed design for a surface probe [21] will also be provided. Several such probes could be deployed by the balloon. The probes could also be treated as ballast and jettisoned at hazard points such as the approach to high cliffs. The probe design will incorporate simple instruments with minimum weight and cost having precision soil analysis capabilities and a VIS/NIR spectroscopic sensor to estimate the abundance of carbonates and silicates. A telemetry antenna can relay data back to a lander or orbiter.

The study for the networked mission scenario will build on the newly completed 1:500,000-scale geologic maps that cover the channel [3,5-8] and previous Viking mission data. The entire study, the scanned and digitized geologic maps, landing sites analysis, probe proto-types, wind studies, and topographic site models will be loaded on the World Wide Web for public access.

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